

**Environmental Quality Sciences  
Chemistry Division  
U.S. Naval Research Laboratory**



**Environmentally Safe Refrigerants  
in the Submarine Fleet**

The Montreal Protocol has mandated the replacement of chlorofluorocarbons (CFCs) with hydrofluorocarbons (HFCs), which result in less damage to the ozone layer. This has a significant impact on the Navy because of the importance of CFC-12 and CFC-114 in shipboard operations. Replacement of these CFCs by HFC-134a and HCF-236fa has a special impact on the submarine fleet because of the unique requirements of submarine atmosphere control.



In order to maintain the submarine atmosphere free of substantial buildups of carbon monoxide, hydrogen and trace hydrocarbons, air is passed through a catalytic burner that removes these constituents. CFCs are unaffected by the burner, but HFCs tend to break down (the property that makes them ozone-friendly) and degrade the catalyst. NRL researchers have been involved in defining conditions under which the burner can be operated without decomposing HFCs, while still performing contaminant control. It was found that operation of the burner at lower

temperatures prevented HFC decomposition, but raised questions about effects on trace organic contaminants. To answer these questions, we have extensively analyzed the components of the atmosphere aboard operational Navy submarines. NRL researchers have been involved in the



acquisition of air samples aboard submarines over short periods (days) and have established protocols under which the crew has obtained samples over the course of full patrols.

Analysis of these samples has been conducted at NRL. The results have provided insight into the concentrations of trace organic compounds in submarine atmospheres. These results have also shown that lower burner temperatures do not adversely effect the submarine atmosphere, ensuring the health of submariners and strengthening the Navy's commitment to environmental compliance.

---

For more information contact:  
Dr. John H. Callahan  
202-767-0719, [John.Callahan@nrl.navy.mil](mailto:John.Callahan@nrl.navy.mil)